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United States Food Administration



Garbage Utilization³⁷

with particular reference
to
utilization by feeding

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The purpose of the Garbage Utilization Division of the Food Administration is to urge the utilization of such waste-food products as are unsuited for human consumption.

If this can be accomplished, there will result an increased meat supply, an increased production of inedible fats, an increased production of fertilizing elements, and a decrease in the cost of garbage disposal.

This bulletin has been largely prepared from data obtained from various publications and from correspondence and conference with men experienced in garbage disposal.

The portion relating to diseases of garbage-fed hogs has been reviewed by Dr. Edw. A. Cahill, of the Massachusetts Bureau of Animal Industry, and Dr. O. B. Hess, of the United States Bureau of Animal Industry. That portion relating to the municipal hog farm at Worcester, Mass., has been reviewed by Mr. Thomas Horne, superintendent of Worcester Home Farm, and Prof. Frederic Bonnet, jr., of Worcester Polytechnic Institute.

GARBAGE UTILIZATION.

WITH PARTICULAR REFERENCE TO UTILIZATION BY FEEDING.

The American garbage pail, with its twenty-odd billion pounds of garbage per year, can well be considered one of our expensive luxuries, and if through high prices, by the efforts of the Food Administration or otherwise, our per capita waste can be reduced by even a small per cent, no small additional supply of foodstuffs will be available.

Undoubtedly a large amount of garbage must exist even when the strictest economy is exercised. The garbage pail can not be entirely eliminated, but it can be enlisted in the cause of food saving. "Put less in the garbage pail and take more out." If all the garbage now being destroyed in cities of from 10,000 to 100,000 population were disposed of by feeding, approximately 30,000,000 pounds of pork, valued at about \$5,000,000, would be available, assuming only 50 per cent efficiency. If we add to this the value of grease and tankage destroyed in cities of over 100,000 population, we have over \$11,000,000 per annum of potential food values being destroyed.

Is your community helping to make up this appalling total? Are you doing anything to cut it down? If not, why not? Because of indifference on the part of your municipal officials? Because of ignorance as to the value being destroyed? Or because of objections on the part of sanitary officials? If garbage has the potential values indicated it is obviously the duty of every municipal official to investigate the present method of disposal in his city. We doubt greatly whether the nonutilization of garbage can be justified in a majority of cases. It certainly can not be justified on sanitary grounds alone, and its destruction is just as wrong as the wastage of edible foodstuffs.

MEANING OF THE TERM "GARBAGE."

The term "garbage" is a general expression for a purely local product. It does not designate any definite material or combination of materials. Its composition and even its general meaning vary in different localities. As used herein the term "garbage" will mean all refuse accumulations of animal or vegetable matter which has been intended for use as food for man. It will not include any material in the nature of ashes, rubbish or refuse, night soil, dead animals, street sweepings, manure, or similar materials.

DIFFICULTY WITH DISPOSAL METHODS.

The garbage produced by a given city is determined almost entirely by conditions in that city; with southern cities a larger amount of vegetable matter will be found than in northern cities,

where the season for fresh vegetables and fruit is not so long; the peculiar diet of any large number of a foreign population has an important bearing on the contents of the garbage cans; cities on the seaboard show a large amount of refuse from sea food, etc.

In view of the uncertainty as to what constitutes garbage, no set rules can be formulated for its disposal. The fact that some one city is successful with a certain method of disposal is no criterion that another city can make an equal success of a similar method.

No doubt a large part of the continual agitation on the part of a majority of our municipalities for a change in their methods of garbage disposal is due to a lack of study of local conditions. Records received from the Food Administration indicate that out of 596 cities of over 10,000 population, 136, or over 22 per cent, are contemplating changes in their method of disposal.

This point is emphasized as it must be clearly understood that in presenting this bulletin the Food Administration is not attempting to establish set formulas to be followed by every city without exception. General principles that must be followed to assure successful utilization can be set forth, but whether the factors governing success are present in a particular locality can only be determined after a careful study of the conditions in that locality.

METHODS OF DISPOSAL.

The principal methods of garbage disposal at the present time are:

- (1) Incineration.
- (2) Reduction.
- (3) Feeding.

Incineration is the method whereby the garbage and other materials are destroyed by fire in especially designed furnaces, known as crematories, incinerators, or destructors.

Reduction is the process whereby the garbage is treated in various ways to the end that the grease it contains is recovered and the fertilizing elements are made available as a fertilizer tankage.

Feeding is the method whereby the garbage is converted into food material. This usually refers to pork, although garbage is being successfully fed to chickens, sheep, and cattle.

There are in existence other methods of garbage disposal, but these can be considered as only temporary; for example, in certain places garbage is successfully disposed of in sanitary fills, or dumps, in which case the garbage when deposited is immediately covered with a layer of earth or other absorbent material. Some cities are having good success with this method; but for this purpose considerable land must be available and it is only a question of time before they will have to give up this method for one of the three outlined above. This is also true of the numerous other ways in which garbage is being disposed of—burial, dumping at sea, in large bodies of water, on dumps, etc.

AMOUNT OF GARBAGE PRODUCED.

Undoubtedly a big factor in the problem of garbage disposal is the fact that such comparatively small quantities accumulate each

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day in every household, and that its nature requires removal at frequent intervals. From one-half to three-fourths of a pound daily, or approximately 200 pounds per annum, is the per capita production in the United States. Obviously the frequent removal of from 1 to 10 pounds of garbage from each residence is a decidedly more expensive operation than would be the collection of the same annual aggregates in cartload lots.

GARBAGE COLLECTIONS.

In making garbage collections two general systems are employed, separate collections and combined collections. With separate collections one set of vehicles remove only the garbage, another set the ashes, and a third the rubbish. With combined collections the garbage, ashes, and rubbish are all placed in the same receptacle and removed by a single set of collection vehicles.

Much has been written on the advantages of combined collections over separate collections, and vice versa. All sorts of sanitary and economic claims have been made for each system. In a general way separate collections permit the utilization of the salable portion of the rubbish, the removal of the unconsumed fuel from the ashes, and the utilization of the garbage. Consequently combined collections are generally used where the material is to be incinerated, although in some cases separate collections are made even when incineration is employed.

The principal advantages claimed for the combined method of collections are that this system is more convenient to the householder, that liquids in the garbage are absorbed by the other materials, that the fly nuisance and odors are thereby lessened, that less frequent collections of garbage need be made, and that the cost of collection is less. All are advantages to a certain extent. Combined collections are undoubtedly more convenient to the householder and are less trouble to the city officials, but in most cases mean more taxes to the public. Whether the liquids of the garbage are absorbed by other materials and the odors, etc., are diminished thereby, is a question of the relative quantities of the respective ingredients in the receptacle. With a properly enforced regulation relative to watertight covered cans, there should be no odor or fly nuisance with separate collections.

It is also practical that the garbage need not be collected as frequently with combined collections as with separate collections, but the converse is also true, that with the combined collections the ashes and rubbish must be collected more frequently, due to their intermixture with garbage.

SEPARATE V. COMBINED COLLECTIONS.

Comparative costs of combined and separate collections at Washington, D. C., based on extensive investigation during 1915 indicate that combined collections would cost about 7 cents per capita per annum less than separate collections. The value of the by-products recovered by utilization after separate collections would absorb this 7 cents and leave a comfortable balance. The total cost of combined collection with incineration was estimated at 68 cents per capita per

annum. With separate collections and utilization the per capita figure was 33.4 cents per annum.

INCINERATION.

Out of 620 cities having thus far reported their method of disposal, 102, or about 16 per cent, are destroying their garbage by burning in some form of incinerator. These 102 cities include 19 of the 66 cities reported by the Census Bureau as having over 100,000 population in 1916.

These cities are destroying about 600,000 tons of garbage per annum, as well as enormous quantities of paper, rags, and other readily salable materials.

The theory of this method of disposal is that all putrescible wastes are to be subjected to high temperatures and converted into a sterile ash. Its use is therefore based on its alleged sanitary advantages over other methods. The fact remains, however, that this method of disposal, like other methods, is only sanitary when properly managed. Because a given city has an incinerator of one sort or another, it does not follow that the putrescible wastes from that city are being reduced to an innocuous ash or clinker.

The cost of installation is comparatively high, as is the cost of operation. While some plants are selling the steam generated, no plant is returning sufficient revenue to offset the cost of operation.

While incineration has proved a failure in a number of cases and a large number of plants have been abandoned, it should be noted that this method is capable of being conducted on a high sanitary plane.

REDUCTION.

Garbage containing no free moisture has a water content of about 70 per cent, or, in other words, by drying a given quantity of garbage its weight can be reduced about three-quarters. Any garbage by-products must be practically free from moisture, and to obtain any appreciable revenue considerable garbage must be available. The necessary apparatus is costly and the operating charges are high. These factors in a majority of cases limit garbage-reduction plants to cities of considerable size. Approximately 100,000 population must be available before a reduction plant is commercially feasible with present-day methods.

Disregarding the numerous rendering plants throughout the country, some of which treat garbage in addition to dead animals and meat trimmings, 29 of the larger cities are having their garbage disposed of by the reduction process. The plants used for this purpose are producing about 72,000,000 pounds of grease and 150,000 tons of fertilizer tankage per annum. The total value of the material recovered at present prices is over \$11,000,000.

The grease now being produced is particularly valuable for its glycerin content, which is estimated to be sufficient to produce 10,000,000 pounds of nitroglycerin. The fatty acids contained in the grease are equivalent to the fatty acids in the manufacture of two hundred million 12-ounce cakes of soap. It is therefore obvious that the reduction process occupies a considerable field in our national resources, particularly since, were this grease not available, an equal

amount of edible and cooking oils would be required for the purposes to which the garbage grease is applied.

Garbage grease therefore is indirectly a food supply, and any additional grease recovered augments our available resources. In this connection it is important to note that 25 cities of over 100,000 population are either burning or dumping their garbage; the grease and fertilizer ingredients contained are not being utilized. It is estimated that this garbage would produce 30,000,000 pounds of grease and 60,000 tons of fertilizer tankage, the sum of the values of these two by-products being nearly \$5,000,000. The grease being destroyed is sufficient for the manufacture of over 4,000,000 pounds of nitroglycerin and sixty-five million 12-ounce cakes of soap.

As an example of the value of the fertilizer tankage, the amount now produced per annum contains approximately 9,000,000 pounds of nitrogen, 22,000,000 pounds of phosphate of lime, and 2,000,000 pounds of potash—enough to replace the soil depletion of about 8,000,000 bushels of wheat. The fertilizer from 25 cities not now utilizing their garbage would replace the nitrogen removed from the soil by about 2,600,000 bushels of wheat.

The reduction process is primarily a manufacturing process and has undergone radical improvement during the past few years. Reduction plants have been justly famous for their odors, but at the present time a number of plants are being operated with efficient management, improved apparatus, and no nuisance.

Recent developments in garbage reduction include the production of alcohol by processes similar to those used in distillation. As much alcohol has been recovered from a ton of garbage as from 4 bushels of corn. This is an additional recovery, as the process does not materially decrease the amount of grease recovered, or the amount of bone phosphate of lime, potash, and nitrogen in the tankage. If anything, the tankage is improved as a more concentrated fertilizer is produced.

COMPARISON OF VALUE BY REDUCTION AND FEEDING.

We have indicated that the reduction process is hardly suitable for cities of under 100,000 population. A proper question would be, "Is pig feeding more applicable to cities now reducing than the reduction process?"

In as far as the monetary return applies, the two methods are practically identical. The reduction process possibly has the advantage of improvement to a greater extent than pig feeding. By improving the breed of the hog, gains might be made more economically, but the reduction process requires only simplified machinery or additional recoveries to make a ton of garbage more valuable.

It also seems that the larger the city, the less adapted its garbage to pig feeding. One might say that smaller cities were better managed, but it is obvious that the difficulties of controlling materials placed in the garbage increase more rapidly than does the population. Although a pig is blessed with a digestive system capable of assimilating almost anything, its efficiency can not be compared with the mechanical digestors of the reduction plants.

While from a purely conservation standpoint pork production may seem more important than the production of grease and fertilizer tankage, the use of the grease recovered releases an equivalent amount of edible oils, while our stock of agricultural fertilizers is so depleted at the present time that fertilizer tankage is a national resource not to be overlooked.

DISPOSAL BY FEEDING.

PRESENT STATUS OF GARBAGE FEEDING.

The test of the practicability of the feeding method of disposal is the selling possibilities of the pork produced. There is no benefit in feeding if the pork is unfit for food or if a popular prejudice will prohibit it from selling freely.

There undoubtedly is a prejudice in the public mind against "garbage"—not particularly against garbage-fed pork, nor reduction or incineration plants, but against the word "garbage" and anything connected with garbage. One might say its disposal was regarded as an illicit business. It is not strange therefore that there is so little general knowledge of the possibilities of garbage utilization and particularly of the feeding method.

Of the 66 cities estimated to have in excess of 100,000 population in 1916 by the United States Census Bureau, 20 or over 30 per cent, report that their garbage is being disposed of by feeding to hogs. Of the 54 cities having between 10,000 and 100,000 population in 1916, from which reports have been received, 200, or over 36 per cent, report their garbage likewise being fed.

This means that even when the production in cities of under 10,000 inhabitants is not considered, nor the suburban and farm population which disposes of almost all its garbage by feeding, the waste food products from over 8,000,000 people are being fed to hogs. This would be sufficient to produce approximately 80,000,000 pounds of pork per annum. But assuming only half of this amount actually slaughtered—and data available indicate that more than 50 per cent efficiency can be expected—it would mean that more than 40,000,000 pounds of garbage-fed pork is being sold each year. At the present price of pork this would have a value of \$6,000,000.

QUALITY OF PORK PRODUCED.

If garbage-fed pork is inferior to grain-fed, the price paid by the packers, who are naturally adverse to paying full price for an inferior article, should indicate the fact. We have not been able to find any market where garbage-fed hogs are being generally sold at a lower price than grain-fed animals. When cases of "softer" pork have been noted it has generally been found that the animals were improperly raised, kept in small pens and not allowed to exercise. There is no theoretical reason why garbage should be bad for hogs. Even putrefying materials may be transformed into delicious human food; for example, lobsters, crabs, shrimp, etc., feed almost exclusively on decaying fish; and the common barnyard chicken will eat and thrive on almost all kinds of so-called filth.

Recently garbage-fed hogs were raised at the experimental station of a Middle Western State and marketed at the same time as hogs fed corn and other grains. The carcasses of these garbage-fed hogs could not be distinguished by the officials of one of the large packing houses from corn-fed hogs, and were even given a higher grading than some of the hogs fed on certain grains.

POSSIBILITY OF DISEASED MEAT.

The chief objection to garbage-fed hogs is that such hogs are alleged to be infected with trichinosis. There are no data available to support such claims; isolated cases have been found, as with grain-fed stock, but we do not believe that there is any evidence to-day that shows garbage-fed hogs, as a class, to be more susceptible to either trichinosis or tuberculosis than grain-fed. The health officer of a large New England city, which disposes of its garbage by feeding, says:

I believe garbage-fed pork is as wholesome as any that can be obtained. I eat it myself when I can get it, and I wish I could afford more of it. I do not see any grounds for the belief that such pork is unwholesome. -- ----

No inspection for trichinosis is made by the Government inspectors at the packing houses. Thoroughly cooking the pork destroys all danger from this parasite and likewise all danger from tubercular germs. The Government urges thorough cooking and condemns the practice of eating raw pork. Some garbage-fed pork from a southern pig farm, claimed to be infected this year, was sent to Washington for examination by the Bureau of Animal Industry, and found to be absolutely free from all traces of trichinosis infection.

Recently, at a meeting in Chicago, the statement was made that garbage-fed hogs were particularly likely to be infected with tuberculosis. This statement was promptly challenged by an official of the Massachusetts Bureau of Animal Industry, a specialist in the diseases of garbage-fed hogs. He said that such a statement was no more justified, from available data, than a statement that because 90 per cent of the hogs from a certain county of a Western State showed lesions of tuberculosis on autopsy, it followed that the feeding of grain caused tuberculosis. There is a well-known reason for the large percentage of corn-fed hogs found infected, and there is likewise a well-defined reason for the few cases where garbage-fed hogs have been found with a large percentage of tuberculosis.

It is interesting to note that in a western city the percentage of garbage-fed hogs found infected as compared with grain-fed hogs found infected by the same Government inspectors, ran about 1 to 20. In an Eastern State, out of about 100,000 pounds of garbage-fed pork, only 41 pounds was condemned by the Federal inspectors. Over 90 per cent of the total number of hogs raised in Massachusetts are said to be garbage-fed, but the percentage condemned is not nearly as high as in certain other States with less stringent inspection laws.

COMPARISON WITH GRAIN-FED HOGS.

In what way does the garbage-fed hog differ from his grain-fed brother? What steps are necessary to make a successful hog raiser.

likewise successful with garbage-fed hogs? What is the secret in this method of feeding?

In very general terms, the following comparisons of garbage-fed hogs with those fed grain can be made.

1. Garbage-fed hogs do not make gains as rapidly.
2. Garbage-fed hogs show greater shrinkage in long shipments.
3. Garbage-fed hogs do not dress quite as high.
4. With proper management the meat produced is equal, and can not be distinguished from that of grain-fed hogs.
5. Garbage-fed hogs are exposed to cholera constantly, and inoculation is indispensable.
6. Cholera in garbage-fed hogs is generally associated with secondary infection but can be controlled by immunization.
7. Garbage-fed hogs are not peculiarly susceptible to trichinosis and tuberculosis.

The secret of success with garbage-fed hogs is, as with grain-fed hogs, largely one of management. The man behind the hogs is the prime consideration. It requires hard work, no little knowledge of hogs, and a large amount of common sense to raise garbage-fed hogs. Cities undertaking municipal hog-raising must remember that the pigs are to be fed on garbage; not on politics. The men who are making a success in this work are up early and late, are progressive, know their hogs, and have a distinct knowledge of what they are doing and how they are doing it.

SIZE OF HERD REQUIRED.

One hundred animals, ranging from pigs to big sows, will eat a ton of garbage per day. This means an average ration of 20 pounds per animal per day. Since the average per capita production of garbage per year is about 200 pounds, this means that the garbage from every 1,000 population will support from 20 to 30 pigs. It must be remembered, however, that the greater part of the garbage is produced in the summer and that a larger herd will be required during that season. The feed value of the garbage produced during the summer months, however, is not as high, thus to a certain extent offsetting the increased quantity. The average monthly percentage of the yearly production for cities in the United States runs about as follows:

	Per cent.		Per cent.
January	7	August	11
February	6½	September	10½
March	7	October	9
April	7½	November	8
May	8	December	7½
June	8½		
July	9½	Total for year	100

The figures vary somewhat with the location of the city, character of the population, etc., but give a general idea of the variance which may be expected.

GAIN IN WEIGHT PER POUND OF GARBAGE EATEN.

A number of tests have been made which establish that a gain of about a pound per day can be expected with growing hogs. This

means roughly that a ton of garbage is equal to 100 pounds of live weight gained. It does not mean, however, that tons of garbage as produced multiplied by 100 equals the live weight to be put on the market. A certain percentage of loss in stock is always to be expected and even with the fullest cooperation with householders, city officials, etc., a certain amount of inedible material, and even inedible garbage, will always be present.

Some feeders are stating that the quality of the garbage now produced is not as good as that of a year ago—that more garbage must be eaten to produce a pound gain. This is not definitely established but it is reasonable to suppose that with high prices, etc., the quality is not as good. We recommend that to cover losses and a possible decrease in the quality of the garbage fed, the amount of marketable live weight be assumed at 1 pound to 50 pounds of garbage. With careful management the ratio could be lowered considerably.

HOUSEHOLD TREATMENT.

Householders should be required to keep garbage free of cans, papers, sawdust, oyster shells, glass, etc. Garbage mixed with any of these foreign materials should not be collected, and an ordinance to this effect should be provided and enforced without fear or favor. Numerous losses can be traced to such foreign matter, particularly such finer particles as readily become embedded in edible materials. Two objects which find their way into the garbage pail in considerable quantities are the very thin glass from electric-light bulbs and phonograph needles.

Undoubtedly a great deal of the difficulty with mixed material is due to carelessness, but the admixture of the objects mentioned above could hardly be due to carelessness. They are not broken crockery, cutlery, paper, meat skewers, etc., which would naturally be associated with garbage. A large part of the trouble is due to the householder's ignorance that the garbage is being fed and that such things are injurious. Surely very few phonograph needles would find their way into the garbage pail if the householders could imagine the tortures suffered by the unfortunate animals, their intestines punctured and torn by the sharp points.

It is unquestionably wise to keep the public continually advised that the garbage is being fed. Individual cases can be easily handled by a courteous notice that the materials found with the garbage are very injurious to the hogs. Word to the local press that an autopsy shows one or more hogs have died through eating foreign material will generally be treated as "news," and the public will be reminded of their responsibilities. The various civic officials must give their hearty cooperation and their notices to the public should explain that the garbage is being fed to hogs. When the public knows that there is a reason for the various ordinances, that they are not simply "red tape," a great improvement will be noticed.

The garbage should be carefully drained by the householder before being placed in the receptacle. The ordinance should prohibit all dishwater, and garbage containing free water of any description should be noncollectible. The water not only adds to the per ton

cost of collection but is very apt to contain lye, strong soap, etc., things which are none too good for the digestive system of the hogs.

In line with the policy of keeping out moisture, the receptacles should be kept covered. This should be done for the further reasons that garbage in a well-covered receptacle is inaccessible to stray cats or dogs, is fly proof, and confines odors. Obviously such receptacles should be made of metal and kept water-tight, although from the feeding standpoint a pervious receptacle would eliminate all free moisture.

FREQUENCY OF COLLECTION.

Aside from the sanitary aspect, the interval of collection is important in that the fresher the garbage the greater its feeding value. In northern cities collection should certainly be made three times per week during the summer months. Once per week during cold weather might be sufficient from the feeding standpoint, but household requirements warrant at least two collections per week. In southern cities daily collections should be made during hot weather, while three per week may be sufficient in the winter. Garbage from hotels and restaurants should be collected daily.

If the disposal of garbage by feeding lowers the cost of disposal in any city, the question of applying such savings to household convenience by more frequent collections is worthy of serious consideration. The big factor at the present time is that the valuable ingredients of the garbage be conserved rather than destroyed. Even if the cost is equal to that of nonutilization, the additional food values recovered are an important item when the amount thus reclaimed is calculated.

BY WHOM SHOULD COLLECTIONS BE MADE?

Special efforts should be made on the part of the city to collect by municipal forces even though disposal by contract is deemed advisable. The municipality can generally overcome collection difficulties better than a contractor. With contract collections, details must be definitely stipulated and can not readily be changed as conditions alter. With municipal collections changed conditions can be readily met.

It is also believed that more competition can be obtained on a contract for disposal only than on a contract for both collection and disposal. The difficulties experienced with disposal are not so detailed as with collection. Collection of garbage is a public utility, whereas disposal is a private affair in which the public is not interested and, up to the present, has had no wish to be interested.

METHODS OF UTILIZING GARBAGE AS HOG FOOD.

There are but two feeding methods worthy of consideration; the first by the municipality, the second by one individual, association, or corporation. In no event should contracts be made with a number of feeders. This has been tried in a number of places and found disadvantageous to both the city and the contractors. In the first place the amount of garbage produced varies from season to season, and even from day to day. It is difficult to proportion this varying

quantity among a number of feeders, when each feeder must provide sufficient stock to consume the maximum amount which he might receive on any given day. It is impossible to prevent a surplus if a certain feeder kills off his stock and leaves the city with an accumulation of garbage and no way of disposal. With a number of individual feeders no heavy bond can be obtained by the city. A contract could safely be let to a single individual, permitting him to sell whatever garbage he chooses to sell. The city could then be protected by adequate bond.

VALUE OF GARBAGE FOR FEED.

In considering disposal contracts it should not be overlooked that the individual is preparing to take certain risks and that these risks warrant him a return on his money commensurable with the risk.

There is at present a mistaken idea throughout the country as to the value of garbage. In a large number of cases it is a question whether the value will be sufficient to pay the cost of collection and transportation. Where collection and disposal both are to be made by the contractor, we doubt if the work will be done without cost to the city unless the quality of the garbage is exceptional and there is keen competition for the material.

The ratio of 1 pound of marketable pork to 50 pounds of garbage has already been established. With pork on the hoof at $15\frac{1}{2}$ cents this would give gross feed value of \$6.20 to a ton of garbage. From this amount must be deducted the cost of labor and materials at the farm, any haul involved, interest on investment, depreciation on buildings, and profit.

DISPOSAL STIPULATIONS.

In making contracts for disposal by feeding, a comparatively long-time contract is advisable. It is obvious that with one-year contracts the cost to the city must be excessive as compared with a longer period, since the contractor must cover the cost of his equipment in the price bid. Upon again bidding he is in a position to take a large profit, his plant being practically paid for and his competitors compelled to add at least a considerable portion of the plant cost to their price.

An additional advantage of comparatively long contracts or municipal operation is that sanitary standards can be insisted on which would be prohibitive with a one-year contract because of their cost. With a one-year contract almost any kind of shelter will have to suffice. The feeding grounds, fences, etc., will all be of the cheapest type obtainable. With a contract for a longer period the city can stipulate and the contractor would be willing to furnish structures of a more permanent type. Any contract to be awarded, however, should require such standards that no nuisance would be maintained at the plant. Obviously in a settled community the opportunity for a nuisance would be greater than in strictly suburban territory and stricter standards would be needed. A suburban location for a farm is therefore more desirable but lengthens the haul and thus increases costs. If the garbage has to be transferred from the collecting vehicles to rail transportation, however, the distance of the farm from

the municipality is not so important, the cost to transport 5 miles being very little less than to transport 20 to 25.

With the present popular demand for this method of disposal there is unfortunately a tendency to lose sight of the advances made in the art. Various statements and newspaper items refer to the success of this method but call little attention to the dangers met with in the farms of 25 years ago. Unless cities adopting feeding disposal give careful attention to sanitary features, a throwback to the old-time farms will be inevitable. It costs money to keep down garbage odors.

LOCATION OF FARM.

The distance of the farm from the municipality naturally depends on local conditions. With wagon or truck haulage, distance is an important factor, but with carload lots an additional 10-mile haul adds very little to the freight rate and a more ideal location may be selected.

The pig farm should be located on soil that drains readily, preferably sand or gravel. For the same reason it is advisable that the land be rolling; the houses should then be located for warmth in winter and coolness in summer. Good drainage is essential at all seasons.

Garbage-fed hogs require abundant drinking water. If any streams or brooks are included in the property they should be carefully traced and their purity established or else fenced off so that the animals will drink pure water otherwise supplied.

The size of the farm necessary varies with the system of handling. With feeding out of doors in all but extreme weather, assume 50 pigs per acre. Under cover the number can be increased to from 400 to 600 an acre.

EQUIPMENT.

The type of shelter to be provided depends on the length of the contract and the climate of the locality in which the farm is to be located. With a short-time contract, the idea should be to give the pig a dry place in which to sleep and keep warm. The types of shelters developed by various experimental stations are well adapted to this end; particularly a type placed on skids for moving about, facing north in summer and south in the winter and with sides so arranged as to be opened for ventilation and shade. Any shelters should be so low as to prohibit any great degree of piling up, with its subsequent suffocation or heated condition conducive to pneumonia. With houses of this type the feeding arrangements will naturally be somewhat primitive and should at least consist of the feeding platforms hereinafter discussed.

With long-time contracts more pretentious equipment can be installed, permanent rather than temporary houses may be erected, and concrete rather than board platforms provided. In such event, the breeding and raising of the stock would probably be undertaken and at least one of the houses provided with heat and artificial light. Under no condition, however, should the animals be kept in small pens. Considerable range is absolutely necessary for the successful operation of a garbage-fed piggery. Fattening stock can be successfully kept in close confines for a limited time.

The other equipment developed for use with grain-fed hogs is likewise used for those fed garbage. No troughs should be used, however, and provision for a feeding floor must be made. These feeding floors and the range required constitute the main difference in the equipment for the two types of animals.

METHODS OF FEEDING.

The two general methods of feeding depend primarily on how the material is delivered to the farm. When in wagonloads or by motor truck it will probably be advantageous to have what are known as feeding lots. These lots are about an acre in size and contain one or more feeding platforms made of lumber and of sufficient size to hold a load of garbage as delivered. The platforms are on skids and have a low rail, a 2 by 4, nailed on edge, to help prevent the garbage being shoved off the platform.

The pigs are permitted to enter the feeding lot only after the garbage has been dumped and the vehicle has left the lot. This prevents injury during unloading and avoids garbage being thrown on the pigs.

After feeding, the pigs are shut out of the lots, the bones gathered, the platforms cleaned and skidded to a new location. The ground beneath and around the old site is plowed under and danger of odors from all spilled garbage or moisture eliminated. The feed lots are changed from time to time and various forage crops grown on the lots thus fertilized by uneaten garbage and manure. This appreciation of the soil is important and land that will benefit by such fertilization can well be purchased rather than land totally unsuited for tillage and the raising of crops.

Where delivery is made in carload lots, the labor expense or rehandling may eat up a large part of the feed value. Under such conditions the hogs are brought to the garbage and the feeding platforms are adjacent to the railroad tracks. Cement platforms soon become eaten by the acid in garbage, but some impervious material must be used where the platforms can not be moved about and the ground underneath turned over. The use of narrow troughs is objectionable. Not only do they become so eaten by the acid as to be hard to clean, but it is much better to spread the material out on a flat surface where the hog will have an opportunity to sort and reject any injurious matter.

The best garbage should be fed to fattening stock or to sows with young pigs. When open-lot feeding is practiced this is a simple procedure, since the material collected in the better portions of the city can be reserved for these particular purposes. With carload lots the same effect is produced by first permitting only the fattening stock to the platforms. After these have become satisfied a second lot, say, young shoats, are let in. In the same way a third or even a fourth lot are given an opportunity. Not only is the better garbage eaten by the most important portion of the stock, but the garbage is eaten more closely. The last lot, generally brood sows, are kept hungry and can be relied upon to clean up all edible material remaining.

The feeding of frozen garbage during the winter months is not considered advisable. It may be unavoidable, but it must be remem-

bered that before this food can be digested its temperature must be raised to that of the stomach. This requires a certain amount of energy, more cheaply supplied by mechanical means than by the body heat of the animal. Considerable frozen garbage is being fed, but not as good gains in weight are obtained. Where the material is thawed before feeding the gains are said to equal those of other seasons.

All authorities agree that abundant fresh water must be available at all times. If possible, some sort of heater should be provided to prevent freezing during severe weather.

STERILIZED V. RAW GARBAGE.

There has been a great deal of agitation throughout the country on the desirability of sterilizing garbage before feeding. In certain localities where feeding was frowned upon up to a short time ago, for alleged sanitary reasons, permission is now granted on condition that the garbage be first sterilized. There is no great objection to feeding sterilized garbage except that people actually having used it state that the animals do not do so well—that the losses are heavier than when feeding the raw material.

At practically all of the large farms sterilizing apparatus has been installed at considerable expense, but such apparatus is not being used at the present time. The difficulty is said to be that sterilization eliminates the opportunity for selection, that any objectionable matter is incorporated into the edible garbage, and can not be refused by the animals.

With so heterogeneous a material as garbage, no definite rule can be stated. Experiments should be conducted in every case to establish the better method. As regards garbage from hotels, restaurants, and Army camps, sterilization does not seem to be objectionable. This, however, is a special type of garbage, and the grease recovered is appreciable. From a financial standpoint the cost with municipal garbage is about equal to the revenue obtained from the sale of grease recovered.

USE OF SUPPLEMENTARY FEEDS.

Most garbage is more or less a balanced ration and no supplementary feeds are required. We find, however, in a number of places that animals are finished off with corn; in others wheat, middlings, or similar feed is given to brood sows, or corn silage is fed on Sundays. As a rule, however, no feed other than garbage is provided. Other feeds, and particularly pasturage, may cause gains to be made in quicker time. With hotel and other special garbage a certain amount of roughage may be desirable and even necessary. The opinions of different raisers vary greatly, with the personal qualifications of the man feeding providing the most important factor. No differences in results are claimed by those supplementing garbage as compared with those feeding garbage alone.

AMOUNT TO FEED.

In using grain feeds it has been conclusively shown that greater gains can be made per pound when the feed is available to the ani-

mals at all times. The same result not unnaturally seems to hold with garbage feeding. It must be remembered that the percentage of water in garbage is much higher than in grain feed. The animal must, therefore, fill up oftener to obtain the same amount of sustaining matter. This means that the garbage must be available to the animals for a considerable portion of the day.

COST OF FEEDING.

The cost of operation at a farm depends almost entirely on conditions at the piggery in question; any comparisons would be misleading unless a careful analysis of all factors leading up to and depending on such costs were considered.

In a general way it is safe to assume that the cost of disposal after the farm is reached, including overhead charges at the farm, would not exceed \$3 per ton. Less costs are reported and the above figure permits of reduction with careful management. A supplementary source of revenue at a farm is the bones recovered. These are collected preparatory to cleaning up the platforms each day. The amount recovered runs from 75 to 100 pounds per ton of garbage.

NUMBER OF ANIMALS PER PEN.

The losses due to "piling up" are so heavy that each hog raiser has very positive ideas as to the number of animals per pen. Some say that as low as 10 is the number to be allowed in a shelter.

Individual pens should be provided for each brood sow, or at the most two sows should share the same pen. Upon being weaned the young pigs should be kept 8 or 10 to a pen until about 8 or 10 weeks old. Efforts should be made to keep in each pen pigs of approximately the same size. When over 60 to 75 pounds in weight they can be turned out into comparatively large lots. The larger the animals the more can be put together in a single inclosure without danger. Our records indicate that as high as five to six hundred animals have been kept in a single inclosure without sufficient piling up to cause harm.

BREEDS TO BE USED.

Practically every breed of hog is being successfully fed on garbage. The tendency is to cross the short-bodied hog with the bacon type. In some instances the boars are of the short-bodied type while in other cases short-bodied sows are used.

With short-term contracts, the tendency is to buy stock at from 75 to 100 pounds in weight and the effort is to secure a thrifty hog that will put on weight rapidly. Practically every grade of hog is being used for this purpose.

The number of pigs raised to maturity with garbage-fed stock is about the same as with grain-fed; namely, from 5 to 7.

BUYING FEEDERS V. RAISING.

There is much controversy between garbage feeders as to the relative merits of hogs raised on garbage from birth and those purchased on the market when at around 100 pounds in weight. Some claim

that the garbage-fed hog has not the strength of the other hog; others will only handle feeders when their regular stock proves inadequate to consume the amount of garbage being produced.

Unquestionably a hog raised from infancy on garbage should be the more successful. The feed is much more bulky than with grain and requires a greater stomach capacity if the same amount of nourishment is to be assimilated. The hog raised on garbage is started as a garbage-feeding pig, his stomach is capable of being distended far beyond that of a grain-fed hog of equal age.

The men who purchase the greater part of their stock point out that they take off the market immature animals at the time they are susceptible to their greatest gains, and that there is considerable difference in the prices per pound for these light hogs and what they obtain later, after feeding to regulation weights. To successfully buy such pigs means that the buyer must be located near a point where considerable numbers of such hogs are put on the market, as the general practice throughout the country is not to market hogs at such light weights.

Local conditions will undoubtedly be the greatest factor in deciding this question. If the farm is operating on a one-year basis, the expenditure for equipment necessary for raising is not justified. Pigs can be purchased more cheaply. If several years of operation are certain, raising the animals may prove the cheaper. Satisfactory results are being obtained under both systems. The management is the essential factor.

CHOLERA OF GARBAGE-FED HOGS.

Practically every garbage feeder believes that the material he is feeding contains considerable hog-cholera virus, and that instead of being exposed to the disease once or twice during their lifetime his animals are exposed daily. Immunization is accordingly of far greater importance than with grain-fed stock.

Constant exposure to cholera virus will undoubtedly build up a considerable resistance to the disease. Where garbage with its virus content has been fed for a number of generations, a higher resistance is to be expected than in grain-fed herds. This higher resistance causes the disease to be less acute, but the *garbage feeder must recognize that his hogs are exposed to considerable hog cholera and that immunization is absolutely required.*

Certain successful garbage feeders are using the single or serum treatment alone and aim to repeat the treatment about every six or eight weeks. This is expensive from the standpoint of both labor and cost of serum used, but is effective. It would seem, however, that equally good or better results could be obtained by using the simultaneous, or virus and serum, treatment. Experience indicates that the danger of this treatment is largely due to incompetent methods of inoculation and serum of low potency. As much as 80 cc. of virus have been given on one side of pig and 100 cc. of serum on the other side without injury, but 2 cc. of virulent virus is sufficient. It must not be forgotten, however, that this treatment must be properly applied by a competent veterinarian or other person particularly qualified. While it is a sure preventative when properly handled, incompetence with this treatment is one of the surest ways of spreading the disease.

Immunity in breeding stock is transmitted to the offspring as a passive or temporary immunity, which generally disappears soon after weaning. It has been definitely established that a pig with passive immunity can not be actively or permanently immunized. It is therefore recommended that a first treatment be given at about 6 weeks of age and the animals be re-treated, with both virus and serum, when at approximately 50 pounds weight. By that time any passive immunity will have had an opportunity to wear off and the hog can be made permanently immune.

We find that even where selected garbage is fed, although efforts to sterilize by cooking have been made, a great deal of trouble is experienced when immunization is not practiced.

Because of the lasting immunity conferred, the simultaneous treatment for cholera control is always preferable to the "serum only" treatment. The cost is practically the same.

The higher resistance built up in hogs bred under garbage feeding conditions makes it more difficult to permanently immunize and the virus used must be the most virulent that can be procured. The doses should always be ample.

TUBERCULOSIS AND OTHER DISEASES.

We have already mentioned that 90 per cent of the hogs in Massachusetts are estimated to be fed on garbage, and statistics show that of over 10,000 hogs slaughtered last year under inspection in that State, only 169 were found infected with tuberculosis. The statement has recently been made that 8 per cent of the animals coming from a well-known pig farm are infected with this disease. It is reported that the animals referred to were not garbage bred, but were purchased by this farm and may have been infected at the time of purchase. Some were found to be tubercular and have died of tuberculosis. Prior to purchasing these hogs, this farm sold over 2,500 hogs and had but 11 condemned.

With pneumonia, the main effort, as with grain-fed hogs, is to prevent the animals from becoming overheated and then cooling off too rapidly. A large number of cases can be expected if the sleeping quarters are permitted to become wet and foul. Good ventilation is also important for the same reason.

In connection with the feeding of frozen garbage, it must not be overlooked that if this practice is continued over a considerable period, the vitality of the animals is likely to be lowered materially; a condition favorable to cholera, pneumonia, or any of the other diseases to which hogs are susceptible. For example, although hog cholera generally diminishes with cold weather, the season of maximum cholera in New England, where frozen garbage is almost exclusively fed, occurs during the extreme winter months.

Aside from cholera, and it is believed that immunization will also control the swine plague frequently associated with it, diseases can be expected in about the same degree as with grain-fed stock. The treatments are identical and the same care is required.

SANITARY STANDARDS.

With a highly putrescible material rather than a practically sterile grain, sanitary measures are relatively more important. Manure and

uneaten garbage should be cleaned up every day and either composted with dry earth or spread on the ground and immediately plowed under.

The paint pot and whitewash brush can not be too much in evidence for the safety of the herd. They are even more needed than with grain-fed stock.

Rats and crows are unnecessary at a pig farm and should be kept under control. Rat proofing should be carefully considered when new construction is to be undertaken. The foot-and-mouth disease several years back in a fine herd is believed to have been brought over by crows from a near-by herd of cattle.

ESTIMATE OF EXPENSE, REVENUE, ETC.

Any estimate of the cost and returns from garbage disposal is so dependent on the conditions in the community as to be practically valueless to another municipality.

A general statement of disposal by feeding as practiced in Worcester, Mass., follows. This city is selected because of the successful operation of its municipal piggery and more particularly since it can be used to illustrate the values recoverable in successive years of operation.

DATA ON WORCESTER, MASS.

Population, 185,000.

Area, 38.4 square miles.

Topography, hilly.

Frequency of collection, twice per week.

Distance of farm from the city, $3\frac{1}{2}$ miles.

Distance of farm from the center of production, $6\frac{1}{2}$ miles.

Cost of collection, \$7.25 per ton (includes haul to farm).

Area actually used for pig farm, 40 acres.

Amount fed, 1917, 6,514 tons (only about 60 per cent of garbage produced is fed at farm. Remainder fed by private collectors).

Minimum head in herd, 2,000.

Approximate capital costs, disposal equipment only.

40 acres, at \$100.....	\$4,000.00
Buildings, platforms, fences, etc.....	37,000.00
Other equipment.....	1,000.00
	<hr/>
	40,000.00

Operating expenses for 1917.

6 caretakers, at \$840.....	\$5,040.00
Additional labor.....	900.00
Grain and bedding.....	1,896.65
Serum and virus.....	2,581.26
Repairs to buildings.....	1,000.00
Miscellaneous, supervision, light, heat, interest, teaming, etc.....	3,500.00
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	14,917.91

Revenue for 1917.

Swine sold.....	44,487.33
Insurance on 435 swine lost by fire.....	4,350.00
Increase in inventory, 1917 over 1916.....	2,900.00
	<hr/>
	51,737.33

Summary.

	Total.	Per ton fed.
Revenue.....	\$51,737.33	\$7.94
Expense.....	14,917.91	2.29
Profit.....	36,819.42	5.65

In 1915 the entire herd either died of the foot-and-mouth disease, were killed because infected with this disease, or were sold; the entire herd was wiped out, and Worcester started in to build up a new herd, under conditions almost similar to those to be faced by anyone first going into the proposition.

Revenue, September, 1915, to Dec. 1, 1917.

Swine sold, 1916.....	\$13,212.84
Swine sold, 1917.....	44,487.33
Insurance on stock lost by fire.....	4,350.00
Stock on hand Dec. 1, 1917 (2,110 head).....	42,000.00
	104,050.17
Less stock purchased September, 1915, to December, 1917.....	10,727.61
	<u>93,322.56</u>

The estimated operating expense during this period, based on the above statement of expense for 1917, is \$33,750, making a net profit of over \$59,000 for the two years and three months of operation.

None of the above figures include depreciation or interest on money invested in live stock. Depreciation on buildings is covered by the repairs made, while the farm suffers no depreciation.

No credit has been allowed for manure produced, although its value is so high that no other fertilizers are purchased for use on the entire farm of 596 acres.

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